Claims

1. An article comprising:

a nanoscopic pathway having a conductivity;

a dielectric insulating the nanoscopic pathway; and

a nanoscopic switch in electronic communication with the nanoscopic pathway being capable of altering the conductivity of the nanoscopic pathway.

2. The article of claim 1, wherein the nanoscopic pathway comprises an organic group.

3. The article of claim 2, wherein the nanoscopic pathway comprises a conducting polymer.

4. The article of claim 3, wherein the conducting polymer is selected from the group consisting of polyaniline, polythiophene, polypyrrole, polyphenylene, polyarylene, poly(bisthiophene phenylene), a conjugated ladder polymer, polyiptycene, polytriphenylene, poly(arylene vinylene), poly(arylene ethynylene), and organic and transition metal derivatives thereof.

5. The article of claim 3, wherein a portion of the conducting polymer comprises a multi-dentate ligand.

6. The article of claim 3, further comprising a metal ion bonded to a portion of the conducting polymer.

7. The article of claim 1, wherein the nanoscopic pathway comprises a pathway of nanoparticles.

8. The article of claim 7, wherein the nanoparticles are selected from the group consisting of nanotubes, metal clusters, semiconductor clusters, colloids and fibers.

9. The article of claim 8, wherein the nanotubes are selected from the group consisting of carbon nanotubes and metallized nanotubes.

10. The article of claim 8, wherein the colloids are selected from the group consisting of gold colloids and silver colloids.

11. The article of claim 8, wherein the colloids comprise colloidal aggregates.

12. The article of claim 8, wherein the fibers comprise graphite.

13. The article of claim 1, wherein the nanoscopic pathway comprises a biological species.

14. The article of claim 13, wherein the biological species is selected from the group consisting of DNA and redox-active enzymes.

15. The article of claim 1, wherein the nanoscopic pathway includes a metal ion.

16. The article of claim 15, wherein the metal ion is selected from the group consisting of transition metals, lanthanides and actinides.

17. The article of claim 15, wherein the metal ion is selected from the group consisting of iron, copper, nickel, cobalt, ruthenium, iridium, manganese, chromium, molybdenum, vanadium, uranium.

18. The article of claim 1, wherein the dielectric is selected from the group consisting of a polymer, a ceramic, a solvent, a vacuum, a gas, a liquid crystal phase, a microphase-separated block copolymer structure and combinations thereof.

19. The article of claim 18, wherein the dielectric comprises a polymer.

20. The article of claim 19, wherein the dielectric polymer is selected from the group consisting of polyolefins, polyesters, polyamides, polyarylenes, polyethers, polyketones, polyarylsulfides, fluoropolymers, polyacrylates, polymethacrylates, polysiloxanes, polystyrene, polyurethanes, proteins and derivatives thereof.

21. The method of claim 19, wherein the dielectric polymer comprises a gel.

22. The article of claim 19, wherein the dielectric polymer is attached to the conducting polymer.

23. The article of claim 22, wherein the dielectric polymer is attached to the conducting polymer via a chemical bond.

24. The article of claim 23, wherein the dielectric polymer is chemically bonded to the conducting polymer via a metal ion.

25. The article of claim 18, wherein the ceramic is selected from the group consisting of a metal oxide and a mixed metal oxide.

26. The article of claim 25, wherein the ceramic is a silicate.

27. The article of claim 26, wherein the silicate is a porous silicate.

28. The article of claim 1, wherein the dielectric comprises a biological species.

29. The article of claim 1, wherein the dielectric includes a metal ion.

30. The article of claim 1, wherein at least a portion of the nanoscopic pathway or the dielectric comprises a block co-polymer.

31. The article of claim 30, wherein the block co-polymer includes blocks comprising a dielectric.

32. The article of claim 31, wherein the dielectric is selected from the group consisting of polyolefins, polyesters, polyamides, polyarylenes, polyethers, polyketones, polyarylsulfides, fluoropolymers, polyacrylates, polymethacrylates, polysiloxanes, polystyrene, polyurethanes, proteins and derivatives thereof.

33. The article of claim 30, wherein the block co-polymer includes blocks comprising a conducting material.

34. The article of claim 33, wherein the blocks comprising a conducting material is selected from the group consisting of a conjugated organic group and nanoparticles.

35. The article of claim 34, wherein the conjugated organic group is selected from the group consisting of polyaniline, polythiophene, polypyrrole, polyphenylene, polyarylene, poly(bisthiophene phenylene), a carbon ladder polymer, polyiptycene, polytriphenylene, poly(arylene vinylene), poly(arylene ethynylene), and organic and transition metal derivatives thereof.

36. The article of claim 34, wherein the nanoparticles are selected from the group consisting of nanotubes, metal clusters, colloids and fibers.

37. The article of claim 1, wherein the dielectric is non-conducting at a first electrochemical potential range and is capable of having a resistivity of less than 10^{-4} times a resistivity at a second chemical potential.

38. The article of claim 1, wherein the nanoscopic switch is positioned in at least a portion of the dielectric.

39. The article of claim 1, wherein the nanoscopic switch is positioned in the nanoscopic pathway.

40. The article of claim 1, wherein the nanoscopic switch and the nanoscopic pathway are capable of being redox-matched.

41. The article of claim 1, wherein the nanoscopic switch is redox-active.

42. The article of claim 1, wherein the nanoscopic switch is a metal ion.

43. The article of claim 1, wherein the nanoscopic switch comprises a biological species selected from the group consisting of DNA and a redox-active enzyme.

44. The article of claim 3, wherein the nanoscopic switch is attached to a portion of the conducting polymer.

45. The article of claim 1, wherein the nanoscopic switch is capable of being activated to alter the conductivity of the nanoscopic pathway.

46. The article of claim 45, wherein the nanoscopic switch is capable of altering the conductivity upon binding to an analyte.

47. The article of claim 1, wherein the nanoscopic pathway is a conductor within a first electrochemical potential range.

48. The article of claim 47, wherein the nanoscopic pathway is a first nanoscopic pathway, and the dielectric comprises a second nanoscopic pathway.

49. The article of claim 48, wherein the second pathway is a conductor within a second electrochemical potential range.

50. The article of claim 49, wherein the second electrochemical potential range is greater than the first electrochemical potential range.

51. The article of claim 48, wherein the second pathway is DNA.

52. The article of claim 1, wherein the nanoscopic pathway and the nanoscopic switch are redox-matched.

53. The article of claim 52, wherein the nanoscopic pathway and the nanoscopic switch are redox-matched within a defined electrochemical potential range.

54. The article of claim 3, wherein the nanoscopic pathway and metal ion are not redox-matched when the metal ion has a first ligand environment, and wherein the nanoscopic pathway and the metal ion are redox matched when the metal ion has a second ligand environment.

55. A sensor comprising the article of claim 1, for detecting the presence of an analyte.

56. The sensor of claim 55, wherein the nanoscopic switch is a detection site for the analyte.

57. The sensor of claim 56, wherein the sensor further comprises two electrodes positioned at either end of the nanoscopic pathway.

58. A composition comprising:

a nanoscopic pathway; and

a polymer isolating the nanoscopic pathway, the nanoscopic pathway having a resistance of at less than 10^{-4} times a resistance of the polymer.

59. An article comprising:

a nanoscopic conduction pathway;

means for insulating the conduction pathway; and

nanoscopic switch means in electronic communication with the nanoscopic pathway being capable of altering the conductivity of the nanoscopic pathway

60. An article comprising:

means for conducting electronic charge along a nanoscopic pathway;

a dielectric insulating the nanoscopic pathway; and

nanoscopic switch means in electronic communication with the nanoscopic pathway being capable of altering the conductivity of the nanoscopic pathway.

61. A method for altering conductivity, comprising:

providing an article comprising a nanoscopic pathway having a conductivity;

insulating the nanoscopic pathway; and

activating a nanoscopic switch positioned in the article.

62. The method of claim 61, wherein the nanoscopic switch is positioned in the nanoscopic pathway.

63. The method of claim 61, wherein the nanoscopic switch comprises redox-active species.

64. The method of claim 61, wherein the nanoscopic switch comprises a metal ion.

65. The method of claim 61, wherein the nanoscopic switch comprises a biological species.

66. The method of claim 61, wherein the activating comprises redox-matching the nanoscopic pathway with the nanoscopic switch.

67. The method of claim 66, wherein the redox-matching comprises adjusting an electrochemical potential applied to the nanoscopic pathway.

68. The method of claim 66, wherein the nanoscopic switch is a metal ion and the redox-matching comprises adjusting a ligand environment around the metal ion.

69. The method of claim 61, wherein the nanoscopic pathway is selected from the group consisting of an organic group, an organometallic compound, a coordination compound, a nanoparticle and a biological species.

70. The method of claim 61, wherein the nanoscopic pathway is conducting at a defined electrochemical potential range.

71. The method of claim 61, wherein the insulating comprises providing a dielectric around the nanoscopic pathway.

72. The method of claim 71, wherein the nanoscopic switch is positioned in at least a portion of the dielectric.

73. The method of claim 71, wherein the dielectric is selected from the group consisting of a polymer, a ceramic, a solvent, a vacuum, a gas, a liquid crystal phase, a microphase-separated block co-polymer structure, and combinations thereof.

74. The method of claim 61, wherein the isolating comprises providing a block co-polymer comprising blocks of conducting material and blocks of dielectric material.

75. A method for detecting the presence of a analyte, comprising:

providing an article comprising a nanoscopic pathway having a conductivity;

insulating the nanoscopic pathway; and

activating detection sites positioned in the article.

76. The method of claim 75, wherein the activating comprises a binding event between the analyte and the detection site.

77. The method of claim 75, wherein the detection sites are positioned in the nanoscopic pathway.

78. The method of claim 75, wherein the detection sites comprise nanoscopic switches.

79. The method of claim 75, wherein the detection sites comprise redox-active species.

80. The method of claim 75, wherein each detection site comprises a metal ion.

81. The method of claim 75, wherein the nanoscopic pathway is conducting at a defined electrochemical potential range.

82. The method of claim 75, further comprising redox-matching the nanoscopic pathway with the detection site prior to the activating.

83. The method of claim 82, wherein the redox-matching comprises adjusting an electrochemical potential applied to the conduction pathway.

84. The method of claim 82, wherein the detection site is a metal ion and the redox-matching comprises adjusting a ligand environment around the metal ion.

85. The method of claim 76, wherein the binding event causes the nanoscopic pathway and the detection site to be redox-matched.

86. The method of claim 85, wherein the detection site comprises a metal ion complex and the binding event occurs between the complex and the analyte.

87. The method of claim 75, wherein the nanoscopic pathway is selected from the group consisting of an organic group, an organometallic compound, a coordination compound, a nanoparticle and a biological species.

88. The method of claim 87, wherein the nanoscopic pathway is a conducting polymer.

89. The method of claim 75, wherein the insulating comprises providing a dielectric around the nanoscopic pathway.

90. The method of claim 89, wherein the detection site is positioned in at least a portion of the dielectric.

91. The method of claim 89, wherein the dielectric is selected from the group consisting of a polymer, a ceramic, a solvent, a vacuum, a gas, a liquid crystal phase, a microphase-separated block co-polymer structure, and combinations thereof.

92. The method of claim 75, wherein the nanoscopic pathway is a first nanoscopic pathway and the insulating comprises providing a second nanoscopic pathway.

93. The method of claim 92, wherein the second nanoscopic pathway is capable of being a conduction pathway at a second electrochemical potential range.

94. The method of claim 92, wherein the second pathway is DNA.

95. The method of claim 94, wherein DNA further comprises a detection site.

96. The method of claim 95, wherein the detecting comprises a change in conductivity of the second pathway upon binding of an analyte to DNA.

97. The method of claim 96, wherein the analyte is a complementary strand of the DNA.

98. The method of claim 96, wherein the analyte is a biological species capable of binding to DNA.

99. The method of claim 96, wherein the analyte is RNA.

100. A method for amplifying conductivity, comprising:
providing an article comprising a nanoscopic pathway;
positioning a plurality of nanoscopic switches in the article; and
activating a number of the plurality of nanoscopic switches, the number being greater than a percolation threshold.

101. A method for reducing conductivity, comprising:
providing an article comprising a nanoscopic pathway;
positioning a plurality of nanoscopic switches in the article; and
deactivating a number of the plurality of nanoscopic switches, the number being less than a percolation threshold.

102. A method for detecting the presence of an analyte, comprising:
providing an article comprising a nanoscopic pathway;
positioning a plurality of nanoscopic switches along the nanoscopic pathway; and
activating a number of the plurality of nanoscopic switches, the number being greater than a percolation threshold.

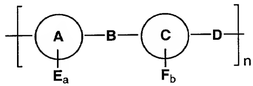
103. A method for detecting the presence of an analyte, comprising:
providing an article comprising a nanoscopic pathway;
positioning a plurality of nanoscopic switches along the nanoscopic pathway; and
deactivating a number of the plurality of nanoscopic switches, the number being less than a percolation threshold.

104. A method for synthesizing a conducting polymer, comprising:
providing a monomer having a first and second polymerization site;
polymerizing the monomer at the first site to produce a first polymer; and
polymerizing the monomer at the second site to produce a second polymer, the second polymer isolating the first polymer.

105. A block co-polymer, comprising:
blocks of a conducting material; and

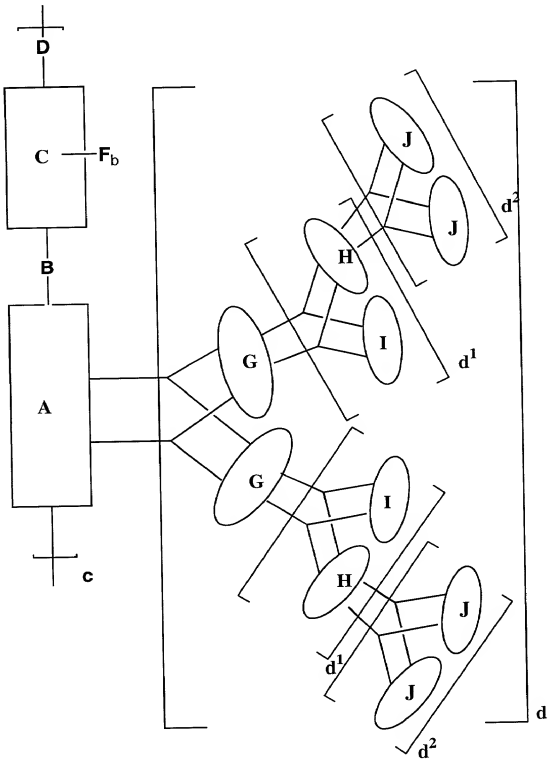
blocks of a dielectric material, the blocks being arranged such that the blocks of conducting material form a nanoscopic pathway insulated by blocks of the dielectric material.

106. The article of claim 3, wherein the conducting polymer has a structure comprising the formula:



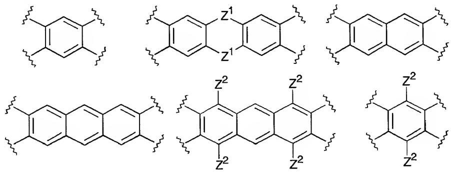
wherein A and C are aromatic groups; B and D can be a heteroatom or metal in the main chain and chosen from a group of N-R, P-R, P=O, S, AsR, Se, or -CC-M-CC-(M=FeL_x, RuL_x, PdL_x, PtL_x, CoL_x, RhL_x, where L is a netural (phosphine, nitrogen, or π-arene based ligand) or charged (nitrogen, oxygen, or charged π-arene ligand) are selected from the group consisting of a carbon-carbon double bond and a carbon-carbon triple bond; and any hydrogen on aromatic group A and C can be replaced by E and F respectively, wherein at least one of E and F comprises the first and second group, a and b are integers which can be the same or different and a = 0 - 4, b = 0 - 4 such that when a = 0, b is nonzero and when b = 0, a is nonzero, and at least one of E and F includes a bicyclic ring system having aromatic or non-aromatic groups optionally interrupted by O, S, NR^1 and CR^1_2 wherein R^1 is selected from the group consisting of hydrogen, C_1-C_{20} alkyl, C_1-C_{20} alkoxy and aryl and n is less than about 10,000.

107. The article of claim 106, wherein E_a is covalently attached to A, and the polymeric composition comprises the structure:

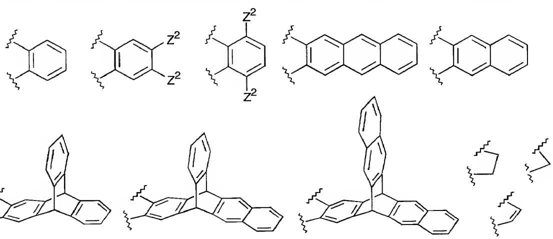

D
C
F_b
B
A
c
G
H
I
J
J
d^2
d^1
G
I
H
J
J
d^1
d^2
d

wherein G, H, I, and J are aromatic groups, d = 1, 2, and $d^1 = 0, 1$, such that when $d^1 = 0$, $d^2 = 0$ and when $d^1 = 1$, $d^2 = 0, 1$.

108. The article of claim 107, wherein G and H may be the same or different, and each is selected from the group consisting of:

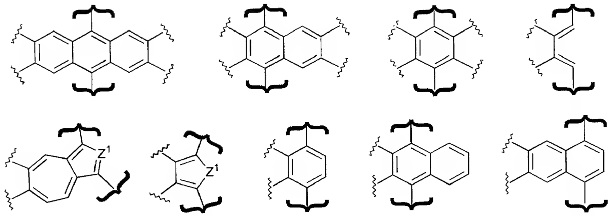


I and J may be the same or different and each is selected from the group consisting of:



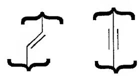
wherein any hydrogen in G, H, I and J can be substituted by R^2, R^2 is selected from the group consisting of C_1-C_{20} alkyl, aryl, C_1-C_{20} alkoxy, phenoxy, C_1-C_{20} thioalkyl, thioaryl, $C(O)OR^3$, $N(R^3)(R^4)$, $C(O)N(R^3)(R^4)$, F, Cl, Br, I, NO_2, CN, acyl, carboxylate, hydroxy, R^3 and R^4 can be the same or different and each is selected from the group consisting of hydrogen, C_1-C_{20} alkyl, and aryl, Z^1 is selected from the group consisting of O, S and NR^8 wherein R^8 is selected from the group consisting of hydrogen, C_1-C_{20} alkyl, and aryl, and Z^2 is selected from the group consisting of F, Cl, OR^3, SR^3, NR^3R^4 and $SiR^8R^3R^4$.

A is selected from the group consisting of:



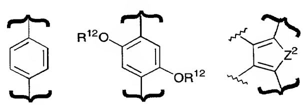
wherein any hydrogen in A can be substituted by R^5, R^5 is selected from the group consisting of C_1-C_{20} alkyl, aryl, C_1-C_{20} alkoxy, phenoxy, C_1-C_{20} thioalkyl, thioaryl, $C(O)OR^6$, $N(R^6)(R^7)$, $C(O)N(R^6)(R^7)$, F, Cl, Br, NO_2, CN, acyl, carboxylate, hydroxy; R^6 and R^7 can be the same or different and each is selected from the group consisting of hydrogen, C_1-C_{20} alkyl, and aryl; Z^1 is selected from the group consisting of O, S and NR^8 and R^8 is selected from the group consisting of hydrogen, C_1-C_{20} alkyl, and aryl;

B and D can be the same or different and each is selected from the group consisting of:



wherein any hydrogen in B and D can be substituted by R^9, R^9 is selected from the group consisting of C_1-C_{20} alkyl, aryl, C_1-C_{20} alkoxy, phenoxy, C_1-C_{20} thioalkyl, thioaryl, $C(O)OR^{10}$, $N(R^{10})(R^{11})$, $C(O)N(R^{10})(R^{11})$, F, Cl, Br, NO_2, CN, acyl, carboxylate, hydroxy, R^{10} and R^{11} can be the same or different and each is selected from the group consisting of hydrogen, C_1-C_{20} alkyl, and aryl;

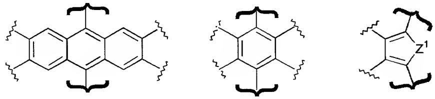
C is selected from the aromatic group consisting of:



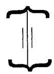
wherein R^{12} is selected from the group consisting of hydrogen, C_1-C_{20} alkyl and aryl; any hydrogen in C can be substituted by F which is represented by R^{13}, R^{13} is selected from the group consisting of C_1-C_{20} alkyl, aryl, C_1-C_{20} alkoxy, phenoxy, C_1-C_{20} thioalkyl, thioaryl, $C(O)OR^{14}$, $N(R^{14})(R^{15})$, $C(O)N(R^{14})(R^{15})$, F, Cl, Br, NO_2, CN, acyl, carboxylate, hydroxy; R^{14} and R^{15} can be the same or different and each is selected from the group consisting of

hydrogen, C_1-C_{20} alkyl, and aryl; Z^2 is selected from the group consisting of O, S and NR^{16} and R^{16} is selected from the group consisting of hydrogen, C_1-C_{20} alkyl, and aryl.

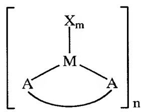
109. The article of claim 108, wherein A is selected from the group consisting of:



and both B and D are:



110. The article of claim 3, wherein the conducting polymer has a structure comprising the formula:

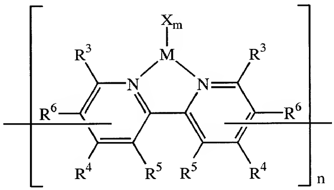


wherein M is a metal ion, n denotes a number of monomer units, n being at least 3, the polymeric structure comprising linkages through at least one atom in , and  and X are selected from the group consisting of alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkenyl, cycloalkynyl, aryl, alkaryl, aralkyl and optionally interrupted or terminated by N, O, P, S, heteroalkyl, heteroaryl, carbonyl, acyl, acyloxy, —CHO, —$COOR^1$, —$CO_2C(R^1)_3$, —$CONC(R^1)_2$, cyano, nitro, alkyloxy, aryloxy, hydroxyl, hydroxyalkyl, amino, alkylamino, dialkylamino, arylamino, diarylamino, —NR^1COR^2, thioalkyl, thioaryl,—SO_2R^1, —SOR^1, —SO_2OR^1, F, Cl, Br, and I; R^1 and R^2 can be the same or different, and each is selected from the group consisting of hydrogen, C_1-C_{10} alkyl,

C_1-C_{10} heteroalkyl, aryl, heteroaryl, hydroxy, F, Cl, Br, and I, and m = 0 - 3.

111. The article of claim 109, wherein the structure comprises a 1-, 2- or 3-dimensional array of n monomer units.

112. The article of claim 3, wherein the conducting polymer has a structure comprising the formula:

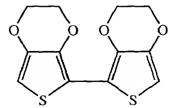


wherein M is a metal ion, n denotes a number of monomer units, n being at least 3, and the polymeric structure comprises linkages through at least one of any R^3 - R^6 units or X and R^3 - R^6 can be the same or different, and each is selected from the group consisting of hydrogen,C_1-C_{10} alkyl, C_1-C_{10} heteroalkyl, aryl, heteroaryl, carbonyl, acyl, acyloxy, —CHO, —COOR ^{1}, —$CO_2C(R^1)_3$, —$CONC(R^1)_2$, cyano, nitro, hydroxy, hydroxyalkyl, amino, alkylamino, dialkylamino, arylamino, diarylamino, — NR^1COR^2, thioalkyl, thioaryl,—SO_2R^1, —SOR^1, —SO_2OR^1, F, Cl, Br, I, or where possible, any two R groups combining to form a ring structure; R^1 and R^2 can be the same or different, and each is selected from the group consisting of hydrogen, C_1-C_{10} alkyl, C_1-C_{10} heteroalkyl, aryl, heteroaryl, hydroxy, F, Cl, Br, and I; and X is selected from the group consisting of alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkenyl, cycloalkynyl, aryl, alkaryl, aralkyl and optionally interrupted or terminated by N, O, P, S, heteroalkyl, heteroaryl, carbonyl, acyl, acyloxy, —CHO, —$COOR^1$, —$CO_2C(R^1)_3$, —$CONC(R^1)_2$, cyano, alkyloxy, aryloxy, hydroxy, hydroxyalkyl, amino, alkylamino, dialkylamino, arylamino, diarylamino, — NR^1COR^2, thioalkyl, thioaryl,—SO_2R^1, —SOR^1, —SO_2OR^1, F, Cl, Br, and I; R^1 and R^2 can be the same or different, and each is selected from the group consisting of hydrogen, C_1-C_{10} alkyl,

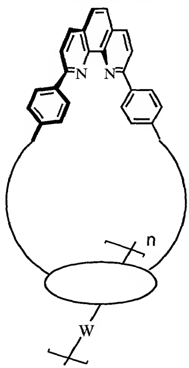
C_1-C_{10} heteroalkyl, aryl, heteroaryl, hydroxy, F, Cl, Br, and I, and m = 0 - 3.

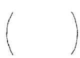
113. The article of claim 112, wherein the structure comprises a 1-, 2- or 3-dimensional array of n monomer units.

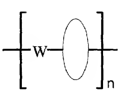
114. The article of claim 112, wherein R^3 or R^6 comprises the formula:



115. The article of claim 112, wherein X comprises the formula:



wherein  comprises two continuous chains of atoms and

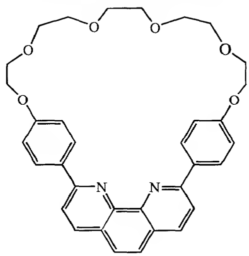
 comprises a species selected from the group consisting of a dielectric and

a conductive nanoscopic pathway, and n is an integer greater than 0.

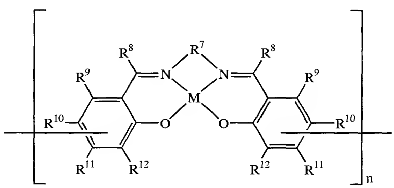
116. The article of claim 115, wherein the continuous chains of atoms comprises chains of methylene units optionally interrupted by an atom selected from the group consisting of oxygen, nitrogen, sulfur and phosphorus.

117. The article of claim 116, wherein the continuous chains comprise chains of ethylene

118. The article of claim 3, wherein X comprises the formula:



119. The article of claim 3, wherein the conducting polymer has a structure comprising the formula:

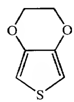


wherein M is a metal ion, n denotes a number of monomer units, n being at least 3, the polymeric structure comprising linkages through at least one atom in $R^7 - R^{12}$ units, and $R^7 - R^{12}$ can be the same or different, and each is selected from the group consisting of hydrogen, C_1-C_{10} alkyl, C_1-C_{10} heteroalkyl, aryl, heteroaryl, carbonyl, acyl, acyloxy, —CHO,

—COOR^1, —CO$_2$C(R^1)$_3$, —CONC(R^1)$_2$, cyano, nitro, hydroxy, hydroxyalkyl, amino, alkylamino, dialkylamino, arylamino, diarylamino, — NR^{1}COR^2, thioalkyl, thioaryl,—SO$_2$R^1, —SOR^1, —SO$_2$OR^1, F, Cl, Br, and I, or where possible, any two R groups combining to form a ring structure; R^1 and R^2 can be the same or different, and each is selected from the group consisting of hydrogen, C$_1$-C$_{10}$ alkyl, C$_1$-C$_{10}$ heteroalkyl, aryl, heteroaryl, hydroxy, F, Cl, Br, and I.

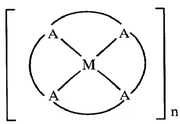
120. The article of claim 119, wherein the structure comprises a 1-, 2- or 3-dimensional array of n monomer units.

121. The article of claim 119, wherein R^{10} is:



.

122. The article of claim 3, wherein the conducting polymer has a structure comprising the formula:



wherein M is a metal ion, n denotes a number of monomer units, n being at least 3, the polymeric structure comprising linkages through at least one atom in , and any  unit or X is selected from the group consisting of alkyl, alkenyl, alkynyl, cycloalkyl, cycloalkenyl, cycloalkynyl, aryl, alkaryl, aralkyl and optionally interrupted or terminated by N, O, P, S, heteroalkyl, heteroaryl, carbonyl, acyl, acyloxy, —CHO, —COOR^1, —CO$_2$C(R^1)$_3$, —CONC(R^1)$_2$, cyano, nitro, alkyloxy, aryloxy, hydroxyl, hydroxyalkyl, amino, alkylamino, dialkylamino, arylamino, diarylamino, — NR^{1}COR^2,